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Heavy Metal Phytoremediation by Water Hyacinth at Ura Cheruvu in Ongole

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ABSTRACT:

Uracheruvu is a municipal garbage dump site situated in the heart of Ongole town, which is the capital city of Prakasham district in Andhra Pradesh. Till 1980, it was used as a fresh water source for the population. Newer fresh water storage tanks, such as the RR tank and the summer storage tank, later substituted it. From then on Uracheruvu has been a victim of gross negligence by the municipal authorities. Its source rivulets have been cut off. Its catchment area has been encroached on by unauthorized welding and painting shops which release their waste containing zinc and lead dust into this disused tank. All the sewers from nearby unplanned residential and commercial areas are draining into the water body. The water from Uracheruvu is seldom used for drinking. But due to constant pollution, the polluted waters of Uracheruvu are seeping into the groundwater aquifers. Recently, municipal authorities have converted it into a garbage dump site, which has an adverse effect on the health of people living in the vicinity of that area. The place is choked up by disposed used coconuts which harbour good breeding sites for mosquitoes. Plastic and polythene bags are directly disposed here instead of recycling. The effects of this dump site are telling on the health of nearby residents. Hence it is high time steps are taken to rectify these problems.

KEYWORDS: Draining[1], lead[2], Municipal Authorities[3] , Ongole, Polluted Waters[4], Residents[5] ,Uracheruvu[6], zinc[7]

I. OUR PAPER AIMS AT

- Reducing the risk of soil and ground water pollution by the heavy metals in the dump site
- Finding an eco-friendly way of disposing the biodegradable wastes into the dump site
- Finding a feasible alternative to the polythene bags to avoid or minimize plastic pollution.

Water hyacinth, a common aggressive water channel weed, was tested to remove the heavy metals in water. The ability of water hyacinth (Eichhornia crassipes Mart. Solms.) to absorb and translocate lead (Pb), and zinc (Zn) was studied in test tanks specially constructed at Saibaba Central School, Ongole. Translocation ability was defined as the quantity of Pb, and Zn removed by the plants in the testing tanks. Water hyacinth plants have reduced the concentration of these trace elements when grown in water environments with low concentrations of the two elements. The absorption capacity for water hyacinth was estimated at 5.23 kg/ha for Pb and 12.7 Kg/ Ha for Zn. This study shows water hyacinth to be a promising candidate for phytoremediation of wastewater polluted with Pb and Zn.

A biogas plant was proposed to be constructed to avoid disposal of biodegradable wastes into the dump site. The water hyacinth plants were also proposed to be used in the bio gas plant after they have bio accumulated the heavy metals from the dump site. The ability of water hyacinth to produce good amounts of bio gas was demonstrated in the laboratory.

The use of bio degradable plastic bags was advocated to reduce the polythene pollution in the dump site. The degradability of the bio degradable plastic bags was experimentally confirmed in the laboratory.

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The solutions we suggested for the reclamation of the garbage dump site are:

- A bio gas plant should be constructed near Uracheruvu for processing of bio degradable wastes and production of bio gas.
- Water hyacinth plants should be grown in the water logged area of the site to reduce the heavy metals.
- The Water hyacinth plants should be harvested at timed interval for biogas production.
- Usage of polythene plastic bags should be avoided. Usage of bio degradable plastic bags should be advocated.

We propagated the fruits of our study to the public and the government authorities by:

- Submitting memoranda to the municipal commissioner, the municipal sanitary officer, the district collector and the district medical and health officer.
- Bringing awareness among residents of Ongole by making a paper statement, distributing pamphlets, giving a speech to our school children in the assembly about using biodegradable plastic.
- Releasing water hyacinth plants into Uracheruvu after obtaining permission from the municipal authorities.

II. DESCRIPTION:

Uracheruvu is a municipal garbage dump site situated in the heart of Ongole town, which is the capital city of Prakasham district in Andhra Pradesh. Till 1980 it was used as a fresh water source for the population. Newer fresh water storage tanks, such as the RR tank and the summer storage tank, later substituted it. From then on Uracheruvu has been a victim of gross negligence by the municipal authorities. Its source rivulets have been cut off. Its catchment area has been encroached on by unauthorized welding and painting shops which release their waste containing zinc and lead dust into this disused tank. All the sewers from nearby unplanned residential and commercial areas are draining into the water body. The water from Uracheruvu is seldom used for drinking. But due to constant pollution, the polluted waters of Uracheruvu are seeping into the groundwater aquifers. Recently, municipal authorities have converted it into a garbage dump site, which has an adverse effect on the health of people living in the vicinity of that area. The place is choked up by disposed used coconuts which harbour good breeding sites for mosquitoes. Plastic and polythene bags are directly disposed here instead of recycling. The effects of this dump site are telling on the health of nearby residents. Hence it is high time steps are taken to rectify these problems. An estimated population of 5000 live around Uracheruvu and many of them use ground water for drinking. Due to seepage from the water body the ground water aquifers are contaminated with heavy metal pollutants such as Pb and Zn.

III. OBJECTIVES:

1. To identify whether the water in Uracheruvu is contaminated with heavy metals or not.
2. To find the source of heavy metal pollution into the water
3. Find the impact of the dumpsite on the health of people living around Uracheruvu.
4. Find an eco-friendly, feasible and viable solution to remove the heavy metal pollution
5. Suggest an alternate disposal method for biodegradable waste
6. Find and suggest a suitable solution for plastic bags pollution.
7. Bring the problem and solutions to the notice of govt. authorities with a request to take necessary action.
8. Share the fruits of our study with public.

IV. NEED FOR THE PAPER:

An estimated population of 5000 live around Uracheruvu and many of them use ground water for drinking. People who live around Uracheruvu have been facing many health problems since the area has been converted into a municipal garbage disposal site.

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The ground water aquifers can get contaminated with heavy metal pollutants such as Pb and Zn from the seepage of water from the dumpsite.The disorganized disposal of biodegradable waste such as used coconuts renders the place a suitable breeding site for mosquitoes and many other insect vectors.Used polythene bags and other plastic wastes piled up in the dumpsite don't allow recharging of ground water and proper decomposition of perishables disposed in them.Repeated requests from the residents around Uracheruvu to shift the dumping yard to another location are being considered by the municipal authorities, but the damage already occurred at the dumpsite must be remedied first. The water in Uracheruvu is already infested with many types of surface phytoplankton and different algae, which do their share of bio remediation. As the water body did not harbour water hyacinth already, we took up the test of its efficacy in removal of the heavy metals from the tank.

4.(a) Hypotheses:

First, to confirm our observations we formulated the following hypotheses and tested them:

1. The water in Uracheruvu is polluted with Zn and Pb above the acceptable norms of Pollution Control Board.
2. The disposal of wastes into the dumping site is causing health hazards to the people living around the site.

V. MATERIAL AND METHODS:

5.1.Water and Plant Sampling

Water from the tank was collected in plastic bottles that had been previously soaked in 10% nitric acid for 48 hours and thoroughly rinsed with distilled water. All samples were filtered using 0.45 µm ceramic candle filters, and acidified to pH 2 with nitric acid in the laboratory. A sample of one liter was collected at a time.

Water hyacinth plants were collected from a drainage canal in Vijayawada as we could not find the plants near Ongole. The plants were collected into clean plastic bags, previously soaked in dilute nitric acid and thoroughly rinsed with de-ionized distilled water. The plants were carefully washed with distilled water and then divided into individual plants with tops and roots, and dried before using for test.

5.2.Analytical Methods

Water samples were collected in plastic bottles that had been previously soaked in 10% nitric acid for 48 hours and thoroughly rinsed with de-ionized-distilled water. All samples were filtered using 0.45 µm cellulose acetate filters, and acidified to pH 2 with nitric acid in the laboratory. The concentrations of Pb and Zn were analyzed by NRDCS with an evaporation nebulizer chromatograph. The minimum detection limits were found to be 0.01 and 0.02mg/L respectively.

VI. TESTING OUR HYPOTHESES:

6.1. Testing whether the water in Uracheruvu is polluted with Pb & Zn or not:

We collected water samples from Uracheruvu in the methods described as above and we got them tested in NRDCS, which is the only institution in Ongole which has the lab facilities to determine the presence of trace of heavy metals in water.

We consulted the geologists and hydrologists in the institution and took their suggestions and opinions.

6.2. Testing whether disposal of wastes into the dumpsite is affecting the health of nearby residents or not:

We designed a questionnaire and surveyed the residents living near the dumpsite about the effects of the waste disposal on their health. We also enquired about their drinking water sources and the changes coming in their lives after the site has been converted into a dumpsite.

VII. PRIMARY CONCLUSIONS:

1. The concentration of lead and zinc ions in the water in Uracheruvu is: lead 0.75mg/l and zinc – 1.86 mg/l respectively.
2. The concentration of lead and zinc ions in the water in the dumpsite is much higher than the accepted levels of Pollution Control Board.
3. The residents around Uracheruvu are facing more health problems since the place has been converted into a dumpsite.
4. The residents at times use ground water for drinking purposes from borewells nearby the dumpsite.
5. There is no characteristic evidence of heavy metal poisoning in them.

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VIII. DISCUSSION:

Developing cost effective and environmentally friendly technologies for the remediation of soils and wastewaters polluted with toxic substances is a topic of global interest. In the scenario under study, there are three aspects that have to be dealt individually. They are:

I. Heavy metal pollution of water in the dumpsite
II. Improper disposal of biodegradable wastes
III. Pollution by surface disposal of plastic bags.

8.1.Testing whether water hyacinth can remove lead & zinc from water or not:

We constructed two test tanks in our school's vermi compost yard. The test tanks had the dimensions of 100 x 100 x 30 cm. The tanks were filled with soil up to 15 cm high and then filled with tap water up to 15 cm heights above the soil surface to resemble a natural pond. We selected the most water soluble salts of lead & zinc i.e. PbNo3 (lead nitrate) ZnSo4 (Zinc sulphate) We weighed the exact quantity of each salt required to increase their concentration equally in both tanks. We dissolved each salt in 1 litre of distilled water and added to the tanks.

We collected water samples from both tanks and labeled them BFT (before treatment). We added the thoroughly washed, rinsed dried water hyacinth plants into one tank the second one was left alone as a control.

We collected water samples from both the tanks

(i) 2 hrs after the addition of plants and labeled AFT (After Treatment) 0
(ii) on 4th day and labeled AFT (After Treatment) 4
(iii) on 8th day and labeled AFT (After Treatment) 8
(iv) on 12th day and labeled AFT (After Treatment) 12
(v) on 24th day and labeled AFT (After Treatment) 24

We got the water samples tested in the laboratory for the quantitative analysis of Zn & Pb ions.

IX. DATA ANALYSIS:

The test reports for water sample analysis were as follows.
Uracheruvu tank water Pb – 0.75mg/ L
Zn – 1.86

Table:1.Data of Sample and Results

Tank		B FT	AFT 0	AFT 4	AFT 8	AFT12	AFT 24
Test tank	Zn	**16.20**	**16.21**	**9.40**	**7.18**	**6.32**	**6.23**
	Pb	**7.45**	**7.45**	**4.32**	**4.03**	**3.89**	**3.81**
Control tank	Zn	**16.75**	**16.75**	**15.61**	**15.01**	**15.31**	**15.23**
	Pb	**7.45**	**7.45**	**7.38**	**7.28**	**7.29**	**7.30**

Note: values are expressed in mg/ L

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9.1.Graphs

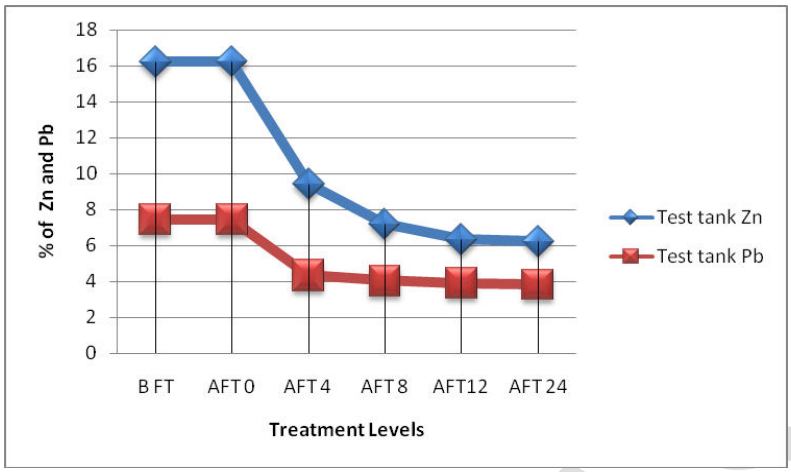

Figure:1. Zn in TT and Pb in TT

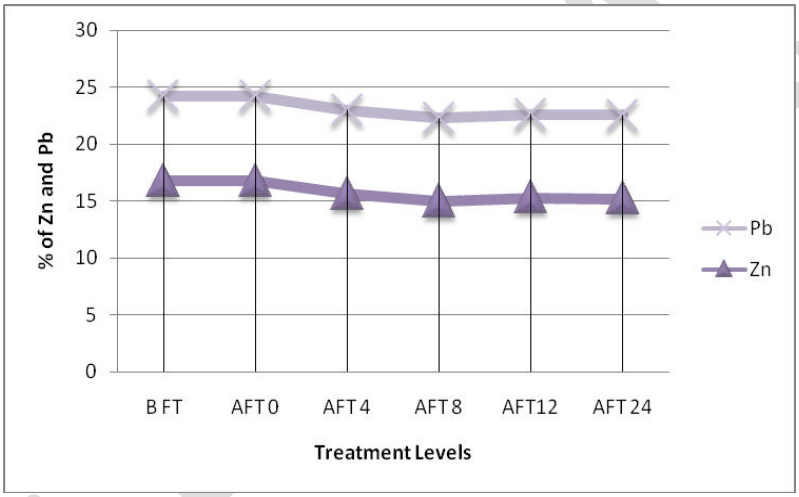

Figure:2. Zn Control and Pb in Control

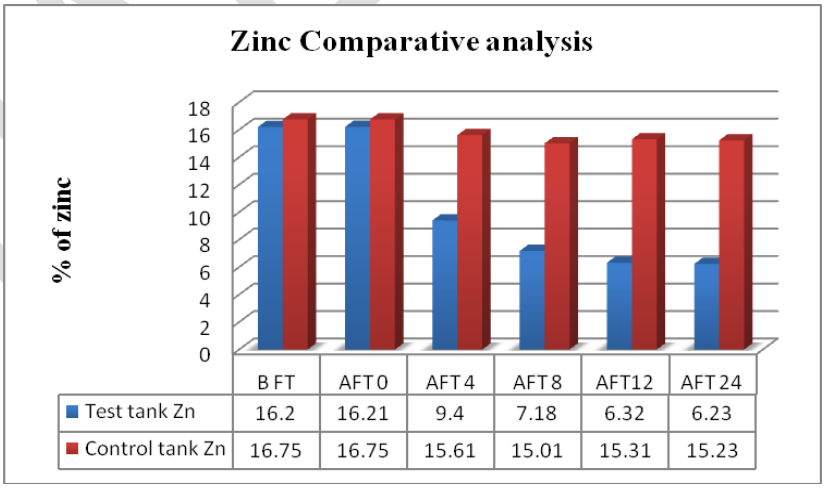

Figure:3. Zinc Comparative analysis

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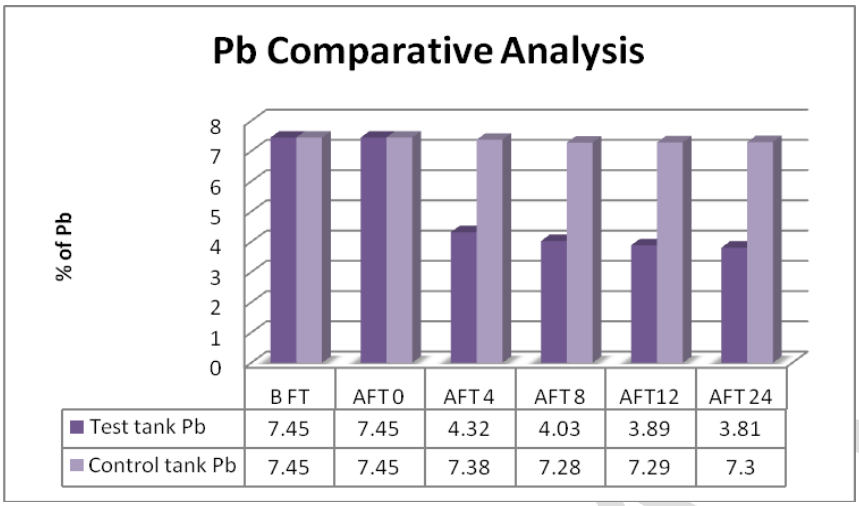
Figure:4.Pb Comparative analysis



X. RESULTS

- Loss of Zn in Test Tank (given value A): from 16.20mg/L to 6.23 mg/L that is for 150 litres 1495.5mg or 1500 mg/ sq.m approx.
- Loss of Pb in Test Tank(given value B) :**7.45** mg/L to **3.81** mg/L that is for 150 litres 546 mg.
- Loss of Zn control tank(given value C) : **16.75** mg/L to **15.23** mg/L that is for 150 litres 228 mg or 230 mg/ sq.m approx.
- Loss of Pb control tank (given value D) : **7.45** mg/L to 7.30 mg/L that is for 150 litres 22.5 mg or 23 mg/ sq.m approx.

From the above data we can say that in 1sq m of pond area the bio accumulation of Zn & Pb by water hyacinth plant is A- C of Zn & B- D of Pb

A-C = 1500- 230 = 1270mg/ sq.m

B-D = 546- 23 = 523mg/ sq.m

If these values are extrapolated for one hectare, then the bio accumulation or rhizofiltration capacity of water hyacinth would be 12.7 Kg/ Ha for Zn, and 5.23 kg/ Ha for Pb.

It means that *in one growing season (24 days) water hyacinth plants can remove 12.7kg of Zn and 5.23kg of Pb from one hectare area of water body.*

10.1.Testing whether water hyacincth can produce good amount of biogas or not:

We tested the biogas productivity of Water Hyacinth plant in our school laboratory. We made a pulp of water hyacinth plant. We inoculated the pulp with cow dung slurry to grow a culture of methanogenic bacteria. We poured the mixture into a large PET bottle and sealed its mouth with a balloon. We can notice the generation of biogas by the swelling and rising of the balloon.

XI. CONCLUSIONS:-

- Water hyacinth can remove Zn & Pb ions in water by bio accumulation.
- The bio-accumulation capacity of water hyacinth is 12.7 Kg/ Ha for Zn, and 5.23 kg/ Ha for Pb.
- The plant is highly active in absorption till 12th day.

XII. PROPOSED SOLUTION TO THE PROBLEM:

Introduction of water hyacinth into Uracheruvu tank might reduce the levels of Zn & Pb in the water.Hence we took the permission of Municipal authorities and released some water hyacinth plants into Uracheruvu tank.We are awaiting the growth of the plants to make further investigations.

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I. Improper disposal of biodegradable wastes:

The biodegradable waste in the dumpsite is disposed directly into surface landfills along with the non biodegradable wastes. This results in delayed and incomplete decomposition of the biodegradable waste which helps breeding of harmful insect pests like mosquitoes and house flies. The biodegradable waste can be shifted to the municipal compost yard situated at Throvagunta but the transportation costs are high. An onsite solution is needed here. Hence ***we proposed to build a biogas plant near the dumpsite***. All biodegradable wastes can be collected and used for biogas production. The sludge formed in the biogas plant can be sold as manure to farmers.

II. Surface disposal of plastic waste:

The public must be educated about avoiding or minimizing their usage of plastic bags. A suitable alternative for the plastic bags is usage of biodegradable plastic bags or cloth bags. Biodegradable plastics can be homemade from starch. Polythene bags with a biodegradable addictive are also Biodegradable. Hence, we procured biodegradable plastic bags from an exporter in Chennai and tested whether they are really biodegradable or not.

We shredded normal polythene bag and a biodegradable plastic bag in to pieces and added them to soil in separate containers. We added water to the containers to accentuate the activity of the soil. We observed the changes in the plastic pieces at regular internals. We found the bio-degradable is showing changes of decomposition, where as the regular polythene has not changed at all.

Hence we concluded that biodegradable plastic decompose much faster than regular plastic. It can be suggested as on alternative for polythene bags.

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